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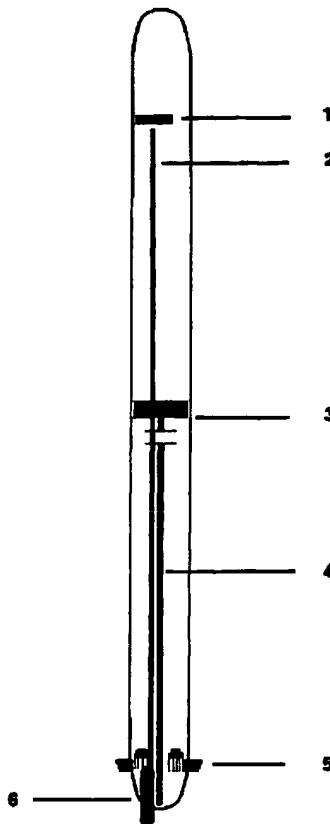
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: HANDWRITTEN CHARACTER RECORDING AND RECOGNITION DEVICE



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(57) Abstract: The invention is an electronic recording and computing device that resides within or on a pen shaped object for the purpose of recording and processing handwritten text or graphics. The device includes a marking implement that may be a pencil, ink pen, non-marking tip, chalk, crayon, marker, paint, laser marking tool, or any other instrument used for writing or marking. The device records motion and marking with one or more of each of the following components: image sensor (1), light source (5), light detector, force sensor (3), contactor, microprocessor, volatile and non-volatile memory, analog to digital converter. Movement of the apparatus is sensed and recorded by means of the image sensor (1) and optical navigation software which tracks microscopic and/or macroscopic features of the writing surface. The orientation of the pen to the writing surface is electronically sensed and recorded by casting a plane wave of light on the surface and detecting the amount received back with several light sensors placed in a specific orientation with each other.

DESCRIPTION

TITLE

HANDWRITTEN CHARACTER RECORDING AND RECOGNITION DEVICE.

FIELD OF INVENTION

The invention relates to handwritten character input and recognition devices. More particularly the device provides a means to electronically record handwritten graphics and record and recognize hand written characters.

BACKGROUND ART

There are numerous patents related to this type of device. The distinguishing features lie in the method or methods used to sense the movement of the device to the writing or marking surface. All such devices employ a button, contactor, or force sensor to sense when the apparatus is in contact with the writing surface. The combination of the above data can be used to record the movement and marking of the pen.

One method attempts to measure forces applied to the pen tip or pen cartridge by using strain gauges, force sensors, piezo-electric devices, or the like (US4751741, US5215397). These forces are used to calculate the movement of the device across the page.

Another method uses accelerometers or gyroscopes to sense acceleration and deceleration of the pen (US188392, US5247137, US5517579).

An optical technique is used to image a known pattern on the page and use this information to calculate movement of the apparatus in (US5226091).

Finally there are also approaches that use a combination of the above sensing techniques. These include a combination of force and optical sensing (US5215397) and a combination of acceleration and ultrasonics (US5517579).

THE PRESENT INVENTION

The invention is an electronic recording and computing device that resides within or on a pen shaped object for the purpose of recording and processing handwritten text or graphics. The device includes a marking implement that may be a pencil, ink pen, non-marking tip, chalk, crayon, marker, paint, laser marking tool, or any other instrument used for writing or marking. The device records motion and marking with one or more of each of the following components: image sensor, light source, light detector, force sensor, contactor, microprocessor, volatile and non-volatile memory, analog to digital converter. Movement of the

apparatus is sensed and recorded by means of the image sensor and optical navigation software which tracks microscopic and/or macroscopic features of the writing surface. The orientation of the pen to the writing surface is electronically sensed and recorded by casting a plane wave of light on the surface and detecting the amount received back with several light sensors placed in a specific orientation with each other. This information is used to correct optical navigation data that is distorted by the orientation of the pen to the writing surface. Data may be processed by on board application software and/or stored for later retrieval. Data may be transmitted through a docking station or via a wireless technology. The transmitted information may later be used with software for tasks such as optical character recognition, signature authentication, or image reconstruction.

It is an object of the invention to eliminate the need for expensive and inaccurate accelerometers or gyroscopes, to eliminate unreliable and inaccurate mechanical systems, and to use inexpensive off the shelf electronic components. It is furthermore an object of the present invention to rely primarily on optical methods for sensing movement and orientation of the device to the marking surface because these well developed technologies allow for a high level of accuracy and repeatability.

DESCRIPTION OF FIGURES

1. An embodiment of the device including 1 image sensor, 2 fiber optic image pipe, 3 button or force sensor, 4 writing implement cartridge and force sensor actuator, 5 light source and light sensor array, and 6 telecentric lens system.
2. A possible arrangement of light sensors (filled) and light sources (not-filled) used for sensing orientation of the apparatus relative to the marking surface.
3. A plane wave of light may be created with an array of light sources thus providing consistent light intensity across a large area.

FIRST EMBODIMENT

A first embodiment of the device is shown in FIG 1 and is constructed in accordance with claims of the present invention. A pen shaped enclosure provides a housing for all components of the system such that the apparatus may operate autonomously.

The embodiment also comprises a marking implement for writing characters or making graphical markings on paper or other surface. The marking implement in this first embodiment is ink. The marking implement

resides within a cartridge such that the cartridge may move within the pen so that it may engage a force sensor for detecting when the tip of the device is in contact with the marking surface (FIG. 1-3)

This embodiment is also comprised of one or more infrared light emitting diodes arranged in a manner to produce a plane wave of light which is to be incident on the marking surface.(FIG 1-5)

The embodiment is also comprised of three infrared phototransistors for detecting infrared light from said light emitting diodes that has reflected off the marking surface. The phototransistors are arranged in a specific orientation to each other in this embodiment of the device(FIG 2). The amount of infrared light detected is used to calculate the distance and or angle of inclination of the apparatus to the marking surface. Using data obtained from two light sensors the angle of inclination of the apparatus relative to the writing surface may be calculated in two orthogonal directions.

The embodiment is also comprised of an imaging system that includes a charged coupled device image sensor, two lenses, and a fiber optic image pipe(FIG1-1,2,6). The two lenses are chosen such that the image obtained by the imaging system provides a telecentric view of the page, this ensures there is little or no distortion in the image. This imaging system is used to rapidly obtain images of macroscopic and/or microscopic features of the marking surface. These images are used in conjunction with optical navigation software capable of comparing these images and mathematically calculating the motion of the apparatus relative to the marking surface.

The embodiment also consists of a microprocessor, memory, and application software that includes said optical navigation as well as software necessary for processing data obtained from said phototransistors. This information may be stored in memory for later retrieval or transmitted in real time to a personal computer or other computing device.

The embodiment of the device also includes a display and several buttons so the user may interact with the device and invoke application software or data transmission.

This embodiment of the device includes electronic hardware and/or software to support the transmission of data via a wired or wireless means.

CLAIMS

1. An apparatus capable of electronically recording handwriting or marking of a surface and/or electronically recording and recognizing handwritten characters and comprising of the following:
 - an imaging system
 - a sensor capable of detecting when the writing or marking tip of the device is in contact with a surface
 - a light source
 - a light detector or light detectors
 - data processing means
 - data acquisition means capable of obtaining signals from said light detector or light detectors for use by said data processing means
 - a writing or marking implement
2. An apparatus according to claim 1 where said imaging system is comprised of one or more of the following: a solid state imaging device which may be a charged coupled device or CMOS image sensor, a lens or series of lenses, and a fiber optic image pipe.(FIG. 1)
3. An apparatus according to claim 2 where said lens or series of lenses comprises a telecentric lens system. Said telecentric lens system is defined here as a lens system that delivers an image of constant magnification with no perspective error when the distance to the objective changes.(FIG. 1-6)
4. An apparatus according to claim 2 capable of obtaining images of microscopic and/or macroscopic features of the writing or marking surface using said image sensor. These features may be inherent to the material or be writing or markings created by the invention.
5. An apparatus according to claim 1 where said sensor capable of detecting when the writing tip of the apparatus is in contact with a surface is a simple contactor or is a force sensor also capable of sensing how much force is being applied to the apparatus against the surface (FIG1-3).
6. An apparatus according to claim 1 where said data processing means are capable of analyzing images obtained from said imaging system for the purpose of calculating movement of the apparatus relative to the marking surface.
7. An apparatus according to claim 1 where said light source is comprised of one or more light emitting elements and where said light source is capable of producing a plane wave of light(FIG. 3). A plane

wave of light is defined in this context as having equal or nearly equal amplitude across the emitted beam or a portion of the emitted beam.

8. An apparatus according to claim 1 where a filter allows only a particular wavelength of light to be detected by said light detectors.
9. An apparatus according to claim 1 where said light detectors are arranged in a manner where they may be used to measure the distance of the light detector to the surface based on the amount of light detected. Said light is light originating from said light source that has reflected off the marking surface. Data obtained from said light is used to calculate the orientation of the plane in which the light detectors reside to the plane of the writing surface.
10. An apparatus according to claim 1 where said data processing means are capable of calculating the angle of inclination in one or more directions and/or the distance to the marking surface based on the amount of light detected by said light detectors.
11. An apparatus according to claim 1 capable of wired and/or wireless transmission of data.
12. An apparatus according to claim 11 capable of sending data directly to a printing device.
13. An apparatus according to claim 1 also comprising an electronic display for providing a user interface or displaying data.
14. An apparatus according to claim 1 also comprising application software that may include, but is not limited to character recognition, email, web browsing, calculator, networking, and function graphing.
15. An apparatus according to claim 1 also comprising one or more buttons for use as a user interface to application software.
16. An apparatus according to claim 1 also comprising one or more lights or light sources for use as indicators to the state of operation of the device.
17. An apparatus according to claim 1 also comprising an electronic system capable of reading barcodes or similar encoded information.

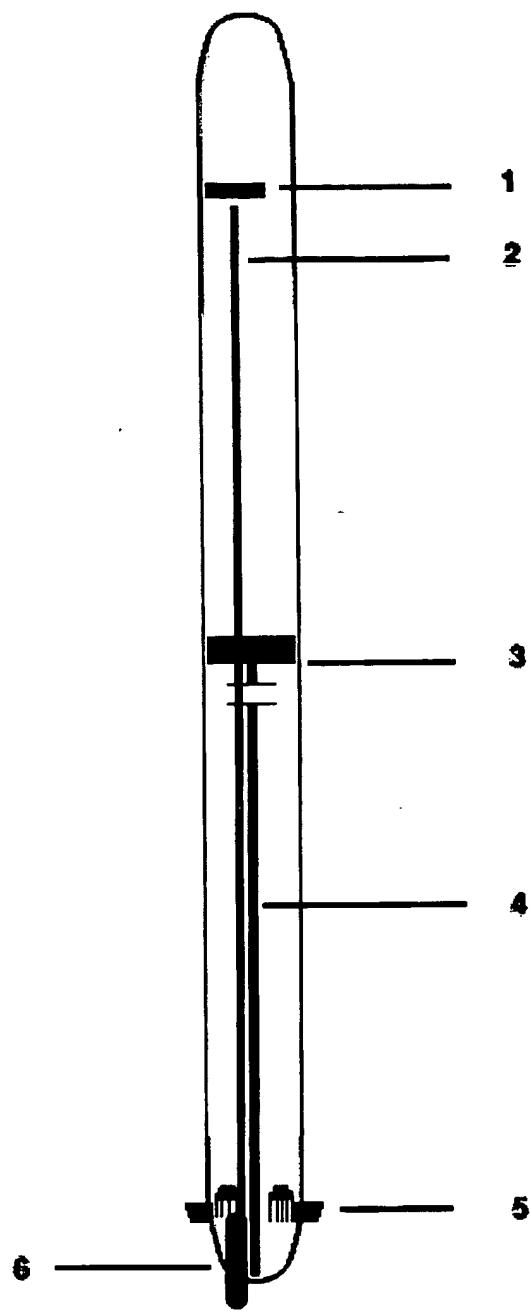


Figure 1

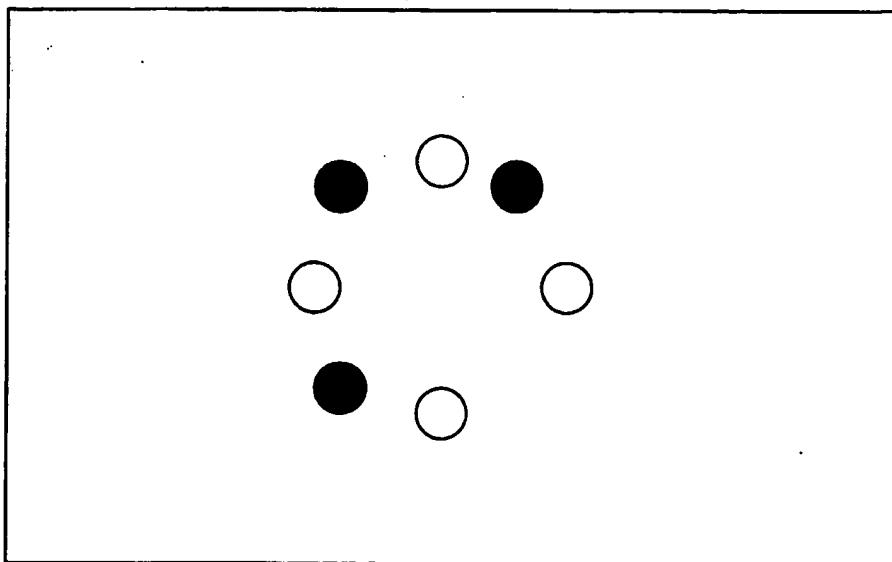


Figure 2

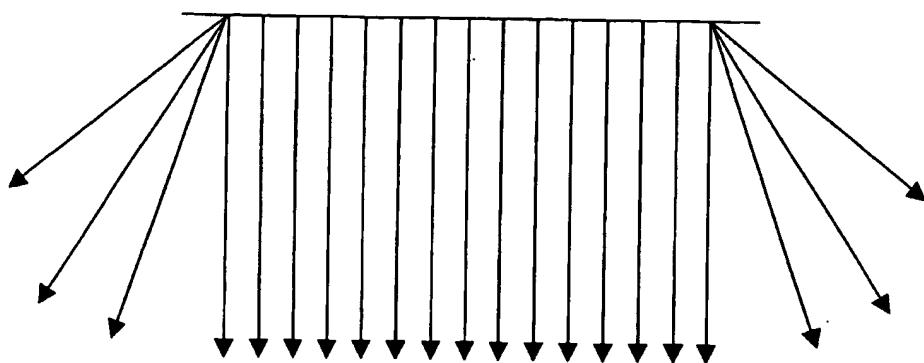


Figure 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/05689

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :G06K 9/22, 7/00, 9/20, 9/00; G09G 3/28, 5/00; G08C 21/00
 US CL :382/312, 314, 188, 116; 345/182, 184; 178/18.09

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 382/312, 314, 116, 188; 345/182, 184; 178/18.09

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST

serach terms: imaging, sensor, handwriting, marking, light, CCD, CMOS, lenses

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|-----------------------|
| Y | US 5,484,966 A (SEGEN) 16 JANUARY 1996, col. 4, lines 37-49, 50-55; col. 5, lines 28-30, 42-44 | 1-17 |
| Y | US 5,103,486 A (GRIPPI) 07 APRIL 1992, col. 4, lines 23-24, 51-58; col. 6, lines 5-7; Figs. 2 and 4 | 1-17 |
| Y | US 5,959,617 A (BIRD ET AL.) 28 SEPTEMBER 1999, col. 4, lines 51-57; Fig. 9 | 1-17 |

Further documents are listed in the continuation of Box C. See patent family annex.

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